Headquarters U.S. Air Force

Integrity - Service - Excellence

Alternative Landfill Covers

Victor L. Hauser

Mitretek Systems

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Topics Covered

- Characteristics of landfills and covers
- Air Force landfill remediation issues
- Alternative landfill covers
- Evapotranspiration (ET) landfill covers
- Sources of information for military planners and managers
- Conclusions

Typical Characteristics of Landfills

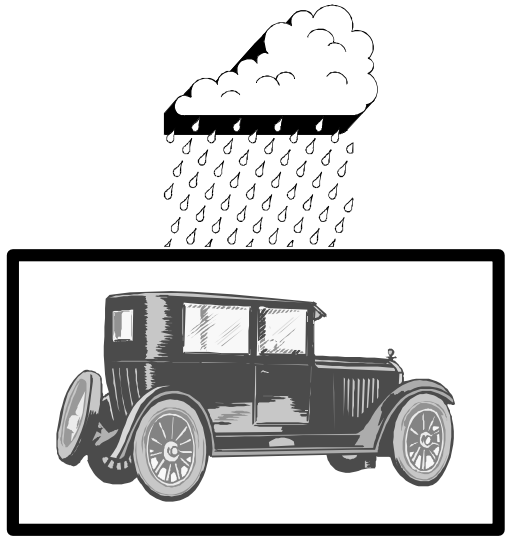
- **Contain large volumes of waste**
- **Potential to contaminate groundwater or the environment**
- **Cover large land areas**
- **Contents have low economic value**
- **Expensive to treat or move the waste**

These landfill characteristics lead to the current concept of waste storage in place

Current Remediation Practice — The Containment Remedy

- **Long-term waste storage in place or warehousing**
- **Objective: Keep it dry to prevent leaching**

Similar to storing antique cars for decades



Landfill Containment Requirements

- Surface cover
- If needed
  - Gas collection and control
  - Groundwater treatment/containment
  - Leachate collection and disposal
- The cover should
  - Minimize infiltration
  - Isolate waste
  - Control landfill gas

Why Focus on Landfill Covers?

- **Required by presumptive remedy**
- **Typically most costly component**
- **Cover choice impacts long-term protectiveness and cost**

Landfill Remediation Issues

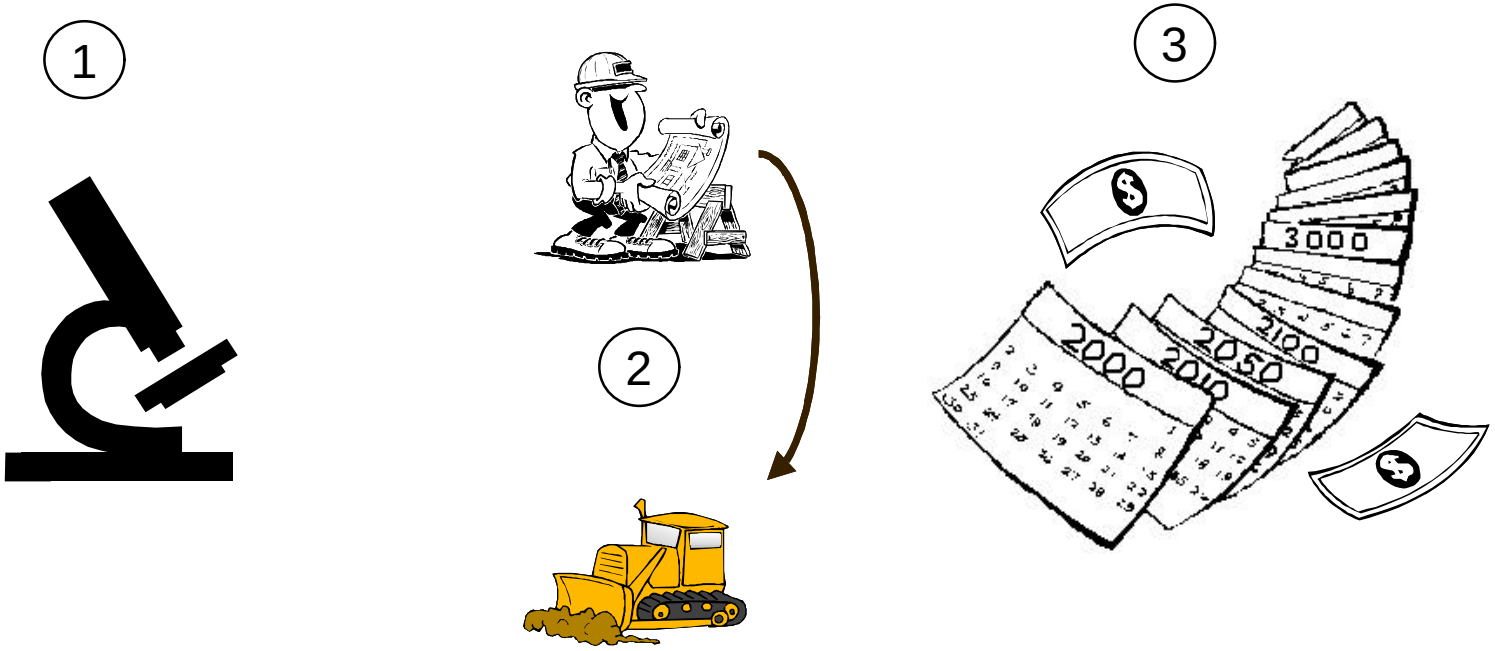
- Storage life—tens or hundreds of years
- No regulatory mechanism for terminating storage
- Costs continue indefinitely

Laws require a commitment to protect human health and the environment.

What steps are needed to meet the requirements of law?

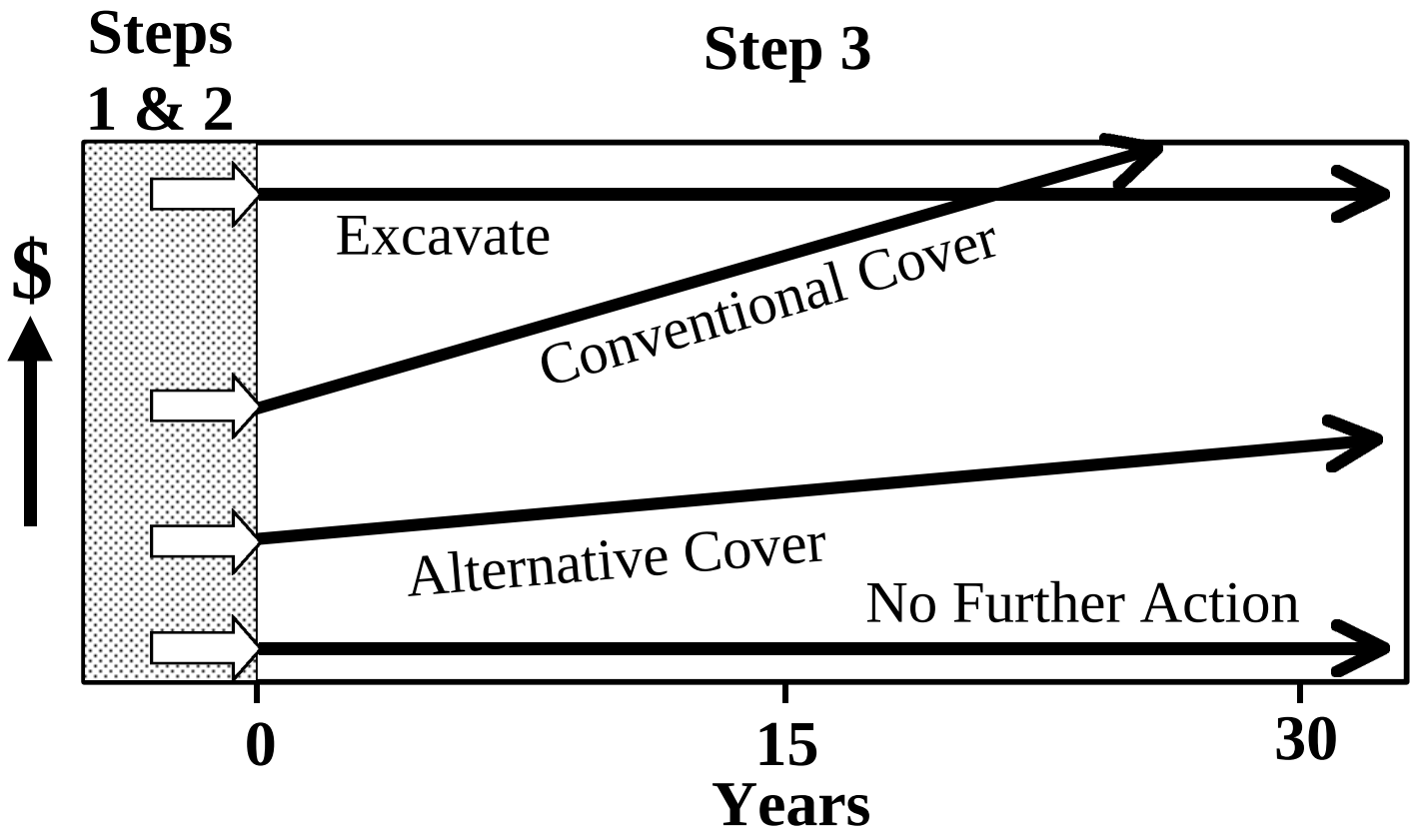
Steps in Landfill Remediation

1. **Site investigation**
2. **Installation**
3. **Long-term maintenance and monitoring**



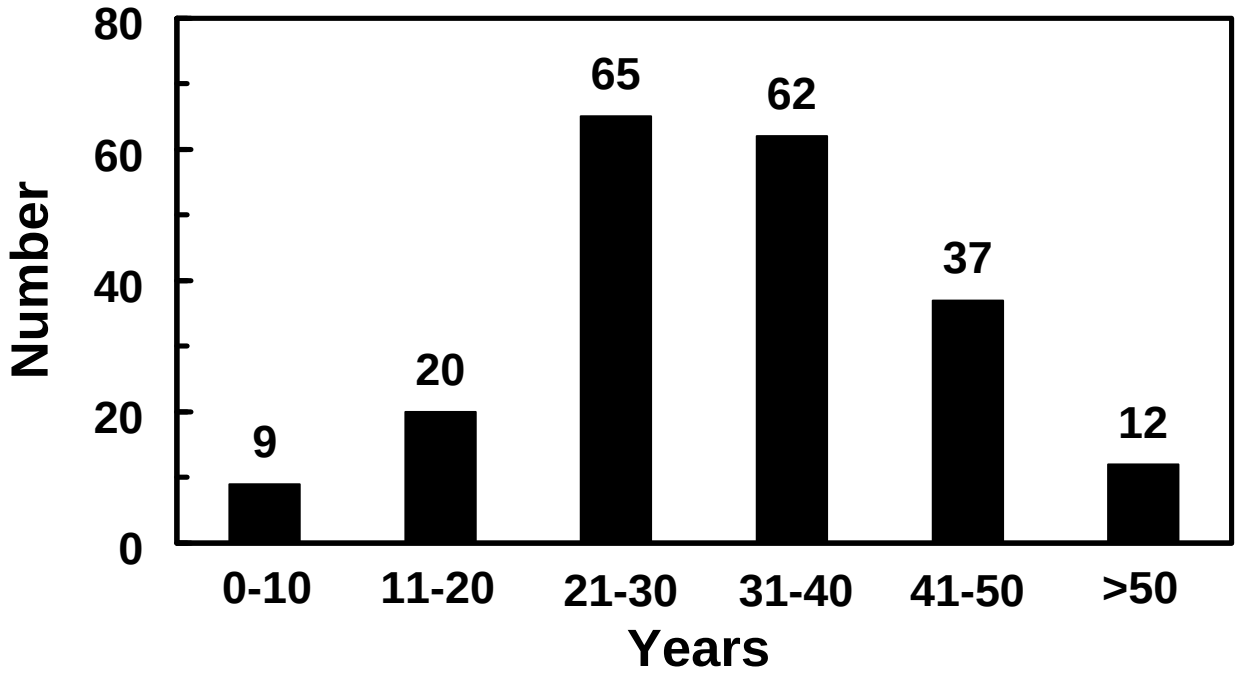
Remediation Comparison

Decisions made during Steps 1 and 2 control costs



Air Force Landfill Characteristics*

Dormancy



86% of landfills inactive for more than 20 years (1998 data)

*Based on sample size of 41% of Air Force landfills (1998 data)

Air Force Landfill Characteristics (Concluded)*

Inactive	**> 99%**
Waste in groundwater	**20%**
Bottom liners	**< 1%**
Remediation complete ***Containment 88%*** ***No further action 12%***	**23%**

Air Force landfills are different from "typical" landfills

***Based on sample size of 41% of Air Force landfills (1998 data)**

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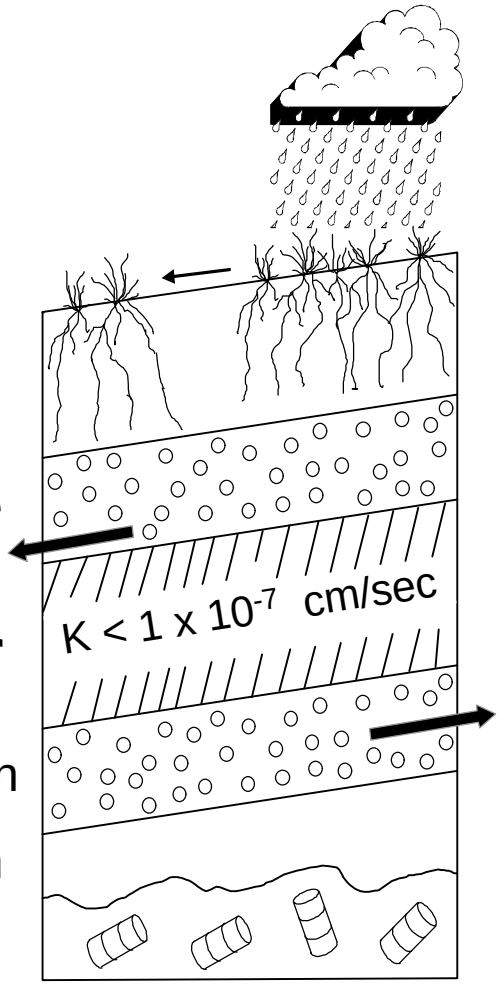
Landfill Covers

- Conventional barrier-type covers
  - RCRA: single- or double-barrier
  - Subtitle D barrier cover
- Alternative barrier-type covers
  - Capillary break
  - Asphalt barrier
- Alternative non-barrier covers
  - Modified surface runoff (rain gutter concept)
  - Vegetative
  - Evapotranspiration (ET) cover

Conventional Landfill Cover



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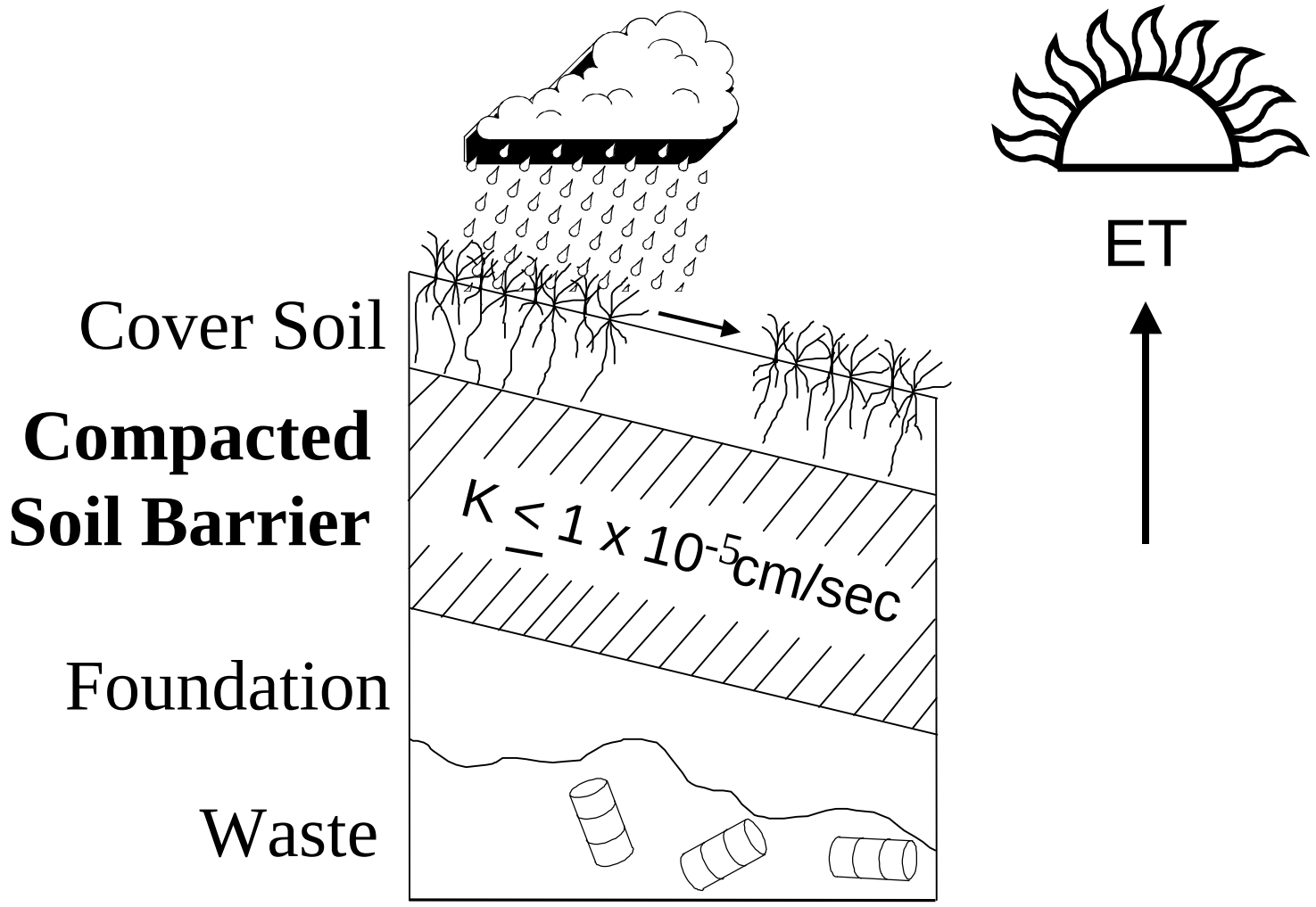
"Impermeable" Barrier Concept

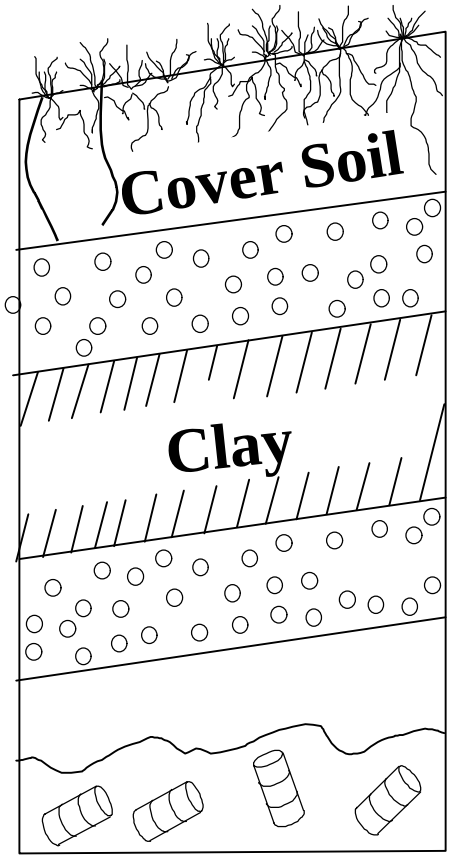
?

Subtitle D — Modified Conventional

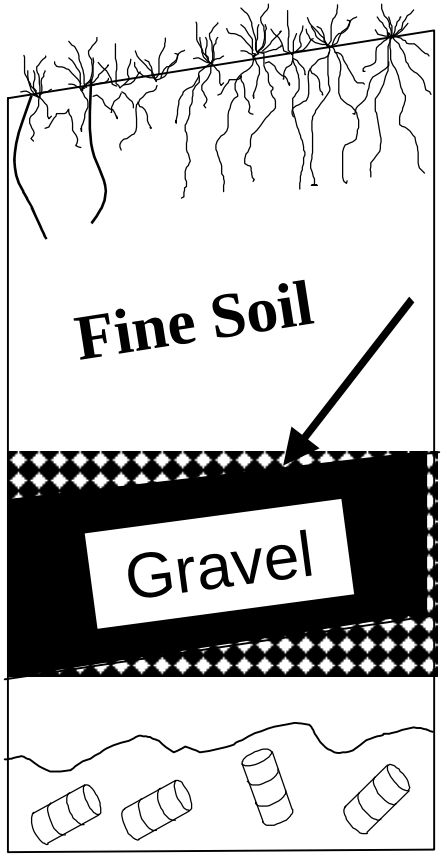


Alternative Covers—Barrier

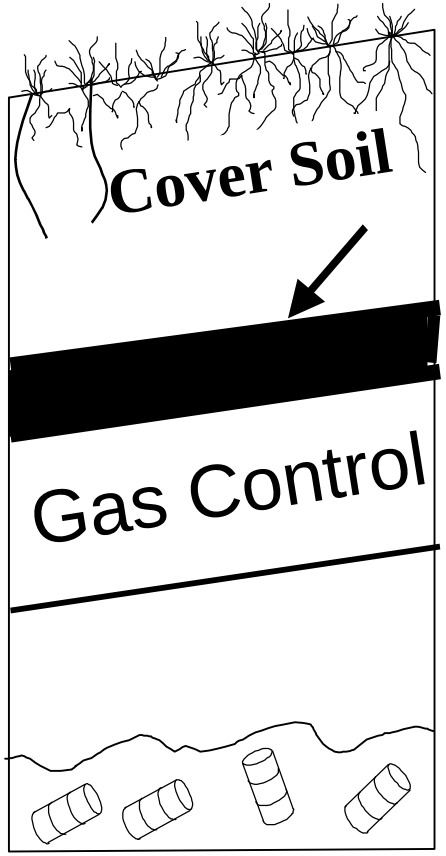
Conventional Clay Barrier



Capillary Break

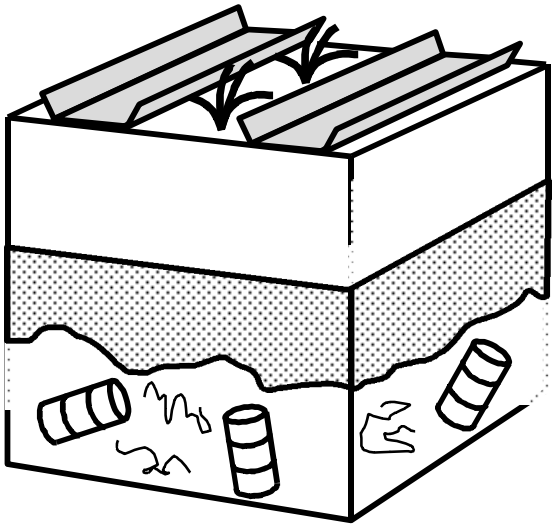


Asphalt Barrier

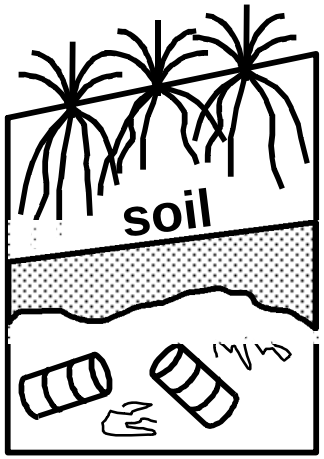


Alternative Covers—No Barrier

Modified
Surface Runoff

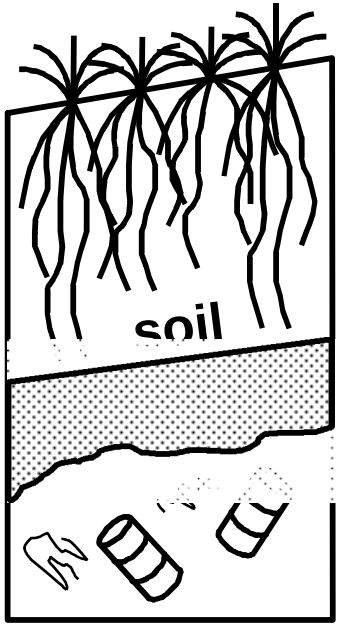


Vegetative



compacted
soil

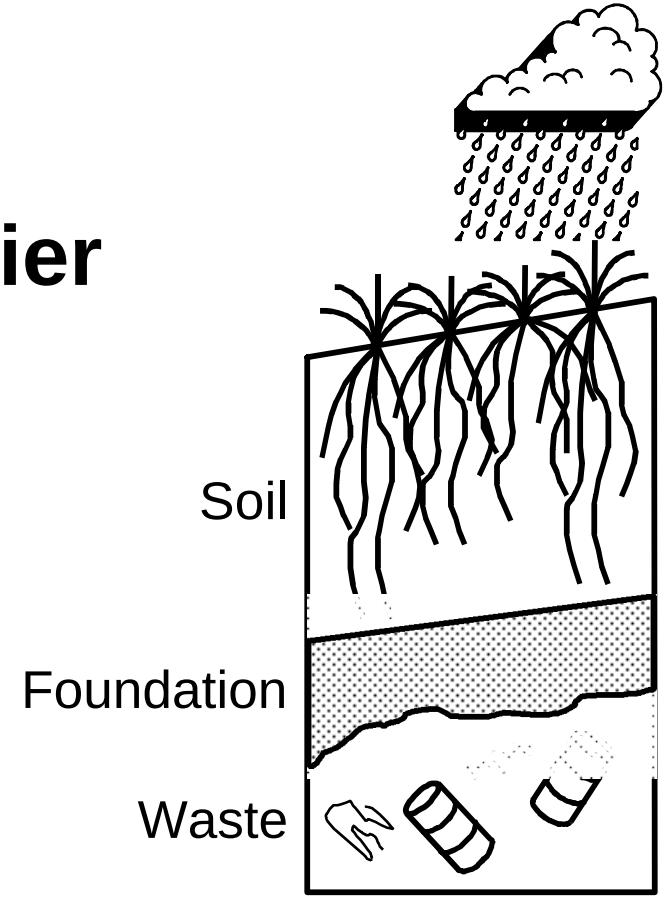
ET Cover

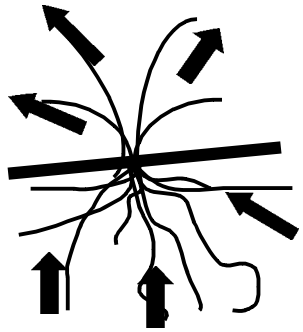


optimized
soil

ET Landfill Cover

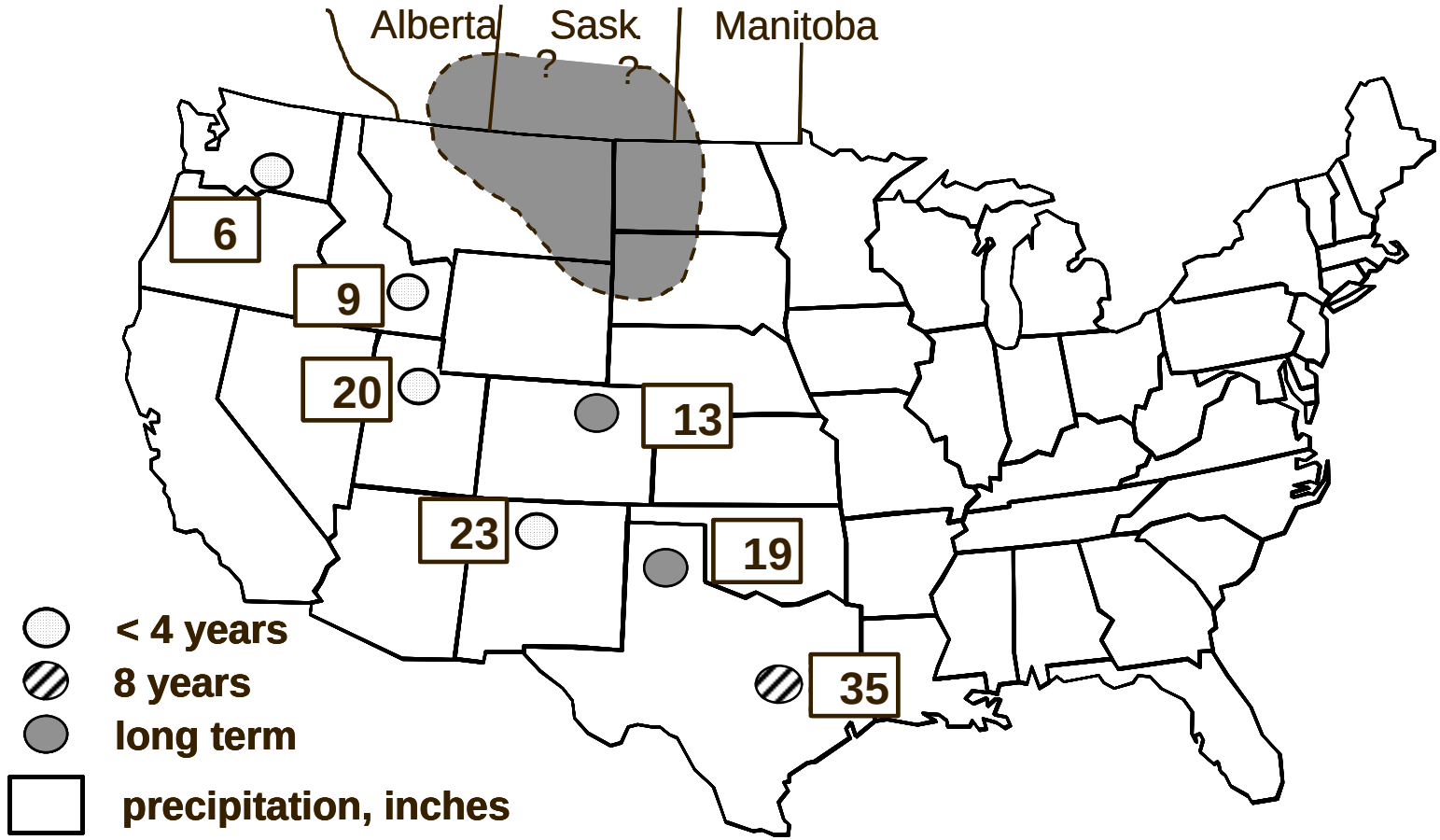
No barrier layer





Plants “pump” water from soil

Field Verification of ET Cover Concept

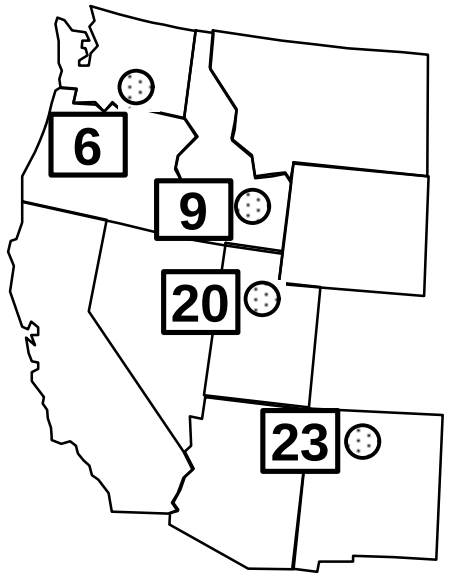


Short-Term Experiments

- One or more experimental treatments similar to ET cover at each site
- *No water movement below grass roots*

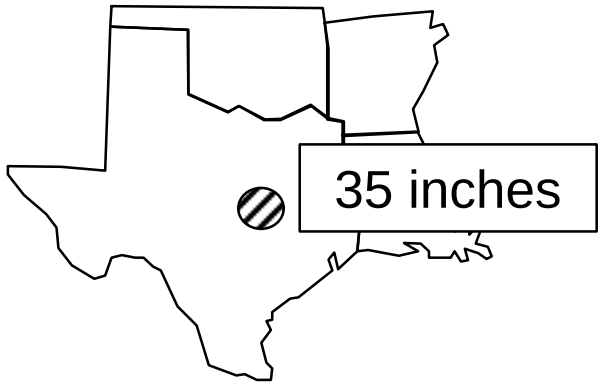
< 4 years

Precipitation inches



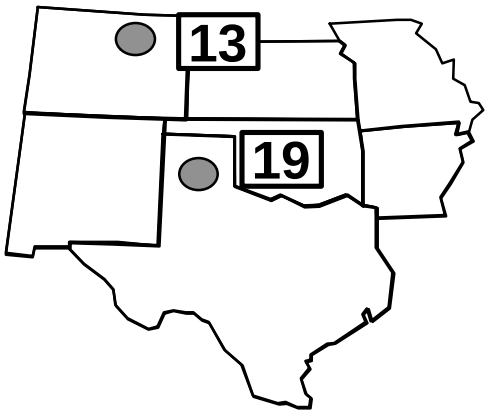
Mineland Experiment

- **Warm, wet climate**
  - **Covers similar to an ET cover**
  - ***8 years – No water movement below grass roots***



Long-Term Measurements

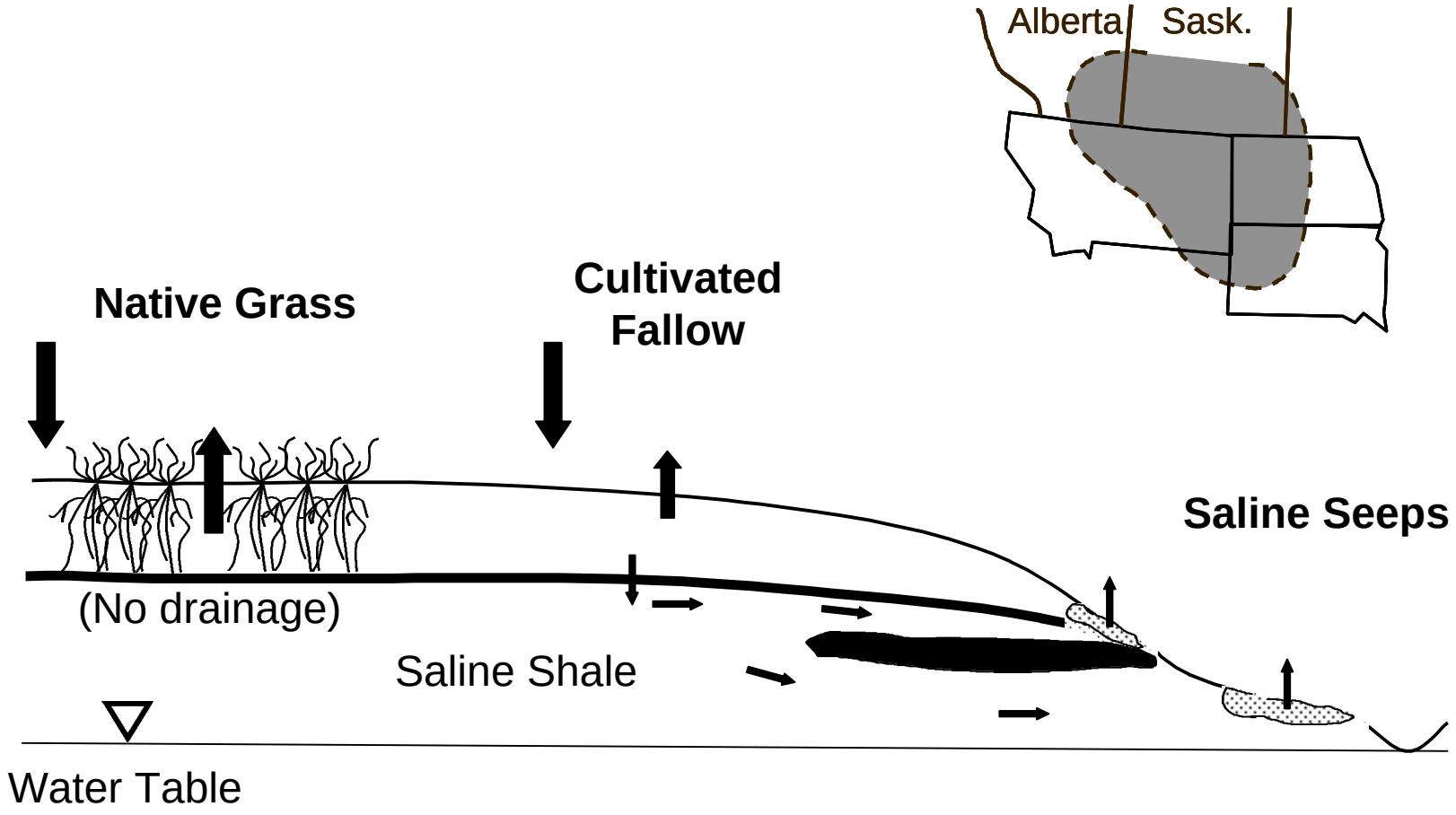
- **33 years - Pawnee National Grasslands (Colo. State. Univ. & USDA)**
- **Centuries - Bushland, TX (USDA)**



Precipitation inches

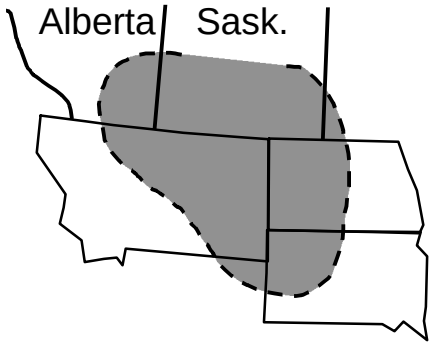
No water movement below roots of native grass

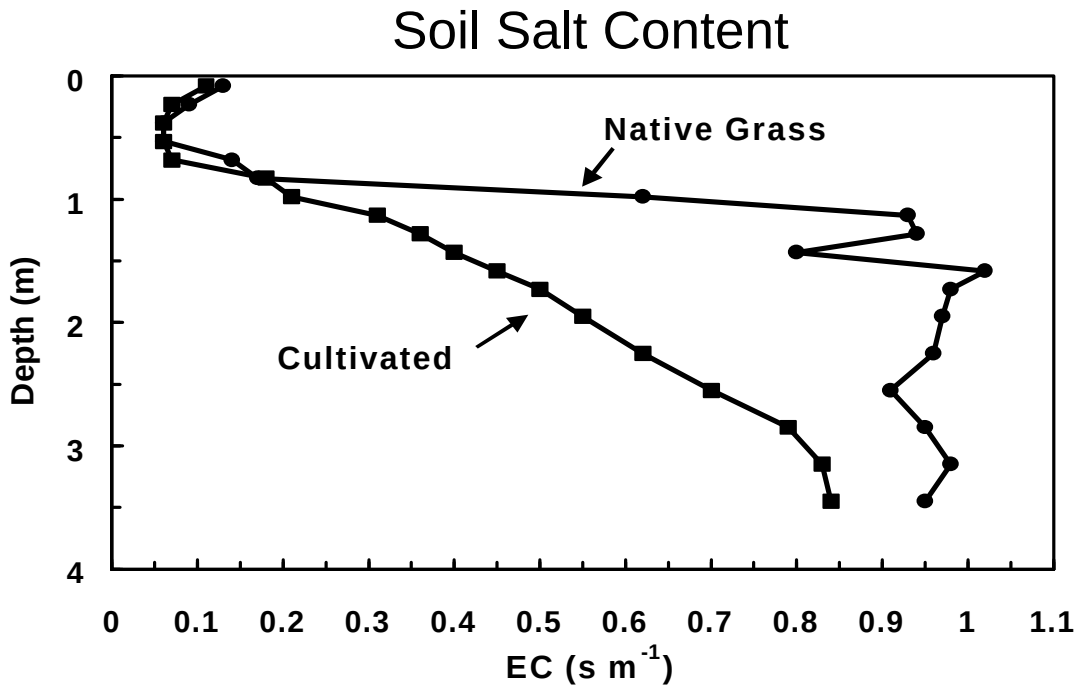
Long-Term Measurements
Saline Seep Region



Saline Seep Region (Concluded)

- **12,000 years—*No water movement below roots of native grass***





Ft. Benton, MT, Ferguson and Bateridge, 1982, SSSA 46:407

Extrapolation to a Landfill Site

- **Model required to extrapolate from proven sites**
- **Environmental Policy Integrated Climate (EPIC) model contains comprehensive models for**
  - **Climate**
  - **Soil**
  - **Plants**
  - **Hydrology (including soil water balance)**
- **EPIC model operates on a daily time step**
- **EPIC model capable of modeling thousands of years**

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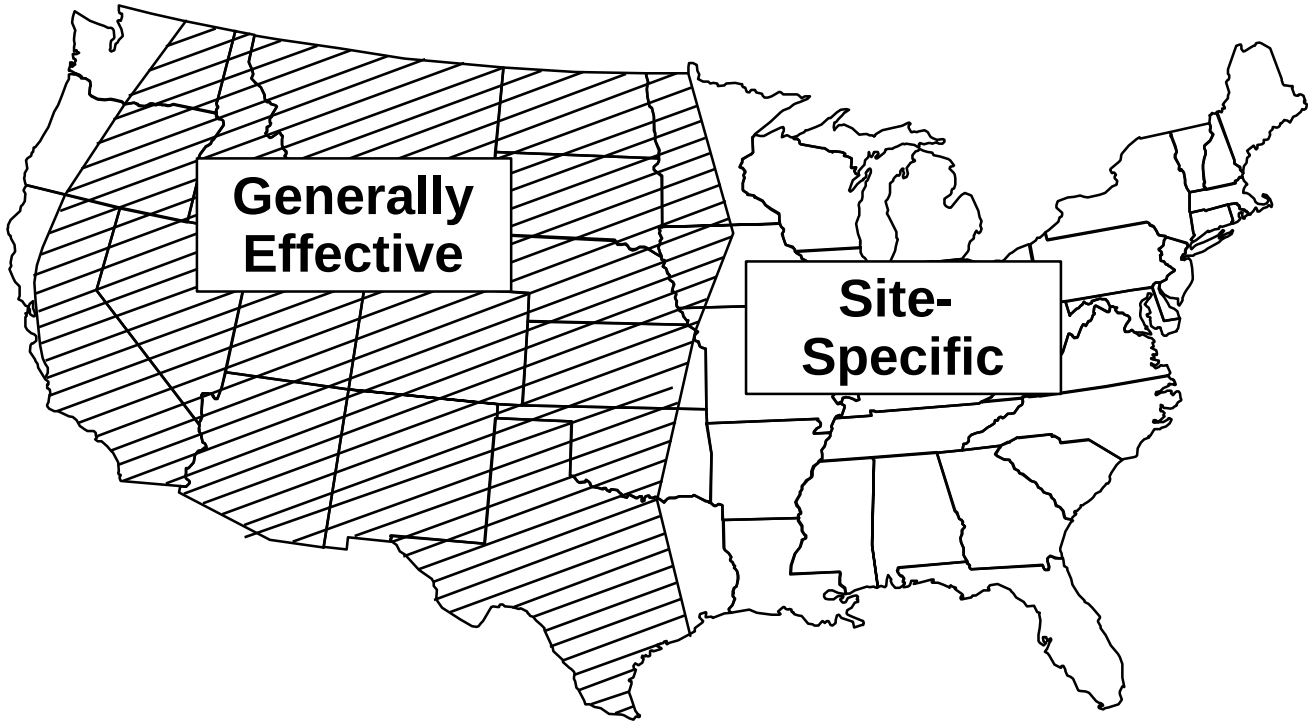
Geographic Application for ET Covers

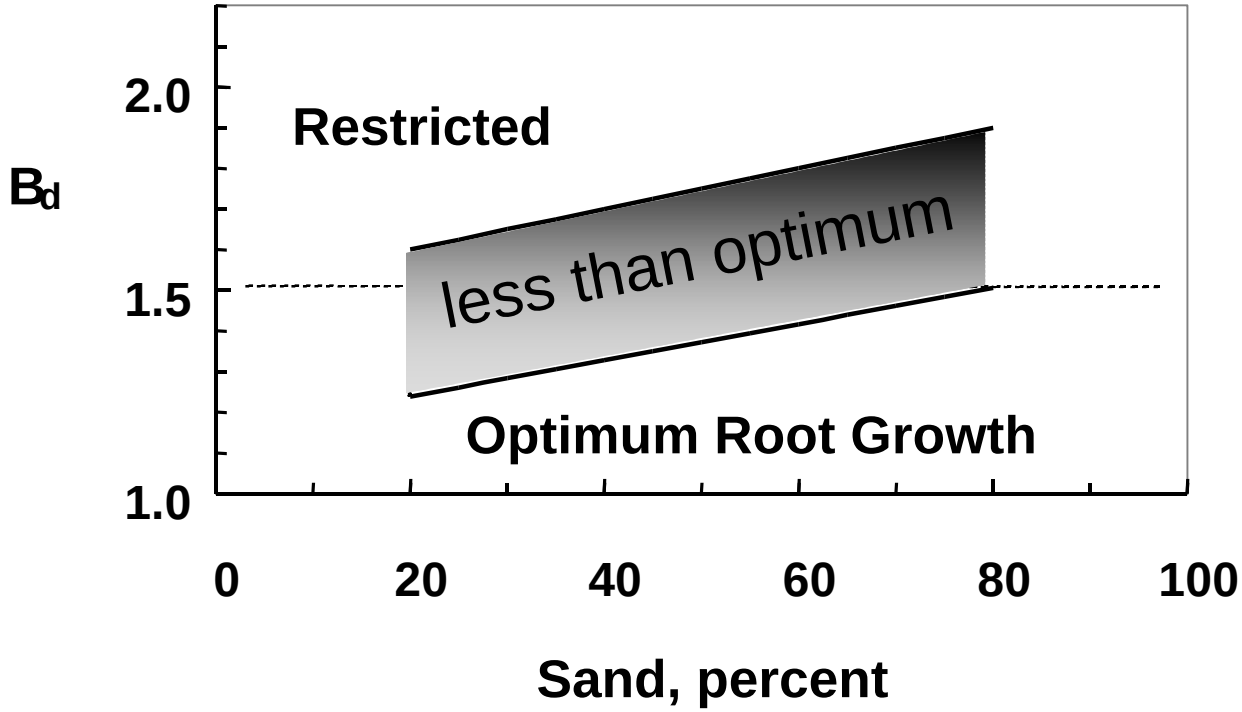


Design Criteria for the Critical Event *on an ET Cover*

- **Objectives**
  - **Evaluate performance with maximum water load**
  - **Minimize percolation through the landfill**
- **Cover design requires**
  - **Adequate soil thickness to store water**
  - **Adequate root growth rate to extract water stored as a result of the design storm event**
- **Meeting the design requirements**
  - **Use variety of models and field tests to evaluate performance**

Optimizing Root Growth (The Overlooked Requirement)

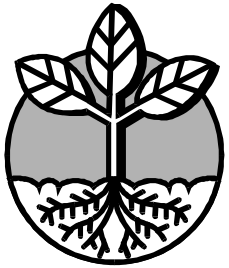
Effect of soil bulk density (B_d) on root growth



From: Sharpley & Williams, 1990, pp. 56-57

Advantages of ET Cover: Protectiveness

- Natural system—less prone to failure
- More protective of human health and environment because it is less prone to failure
- Design and construction time—less than conventional covers
- Long life (many decades to centuries)



Advantages of ET Cover: Cost Avoidance

- **Conservative estimate (most of country)**
  - **Save $150K to $200K per acre**
- **Estimates for one landfill in a semiarid climate**
  - **Save $212K to $247K per acre**
- **Potential Air Force cost avoidance**
  - **$500 to $750 million**

Impact of Reuse on Landfill Cover Performance

- **Landfills cover large areas, thus reuse is desirable**
- **Compatible reuse**
  - **Nature areas or wildlife preserves**
  - **Hiking and biking trails**
- **Incompatible reuse (substantial risk)**
  - **Buildings and parking lots**
  - **Golf courses**

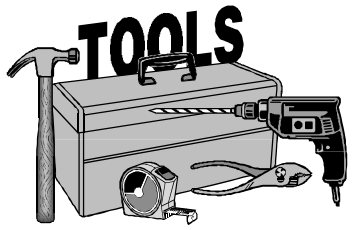
Available from the Air Force Center for Environmental Excellence:
Golf Courses on Air Force Landfills

http://www.afcee.brooks.af.mil/er/ert/erthome.htm

AFCEE Resources for Landfill Remediation

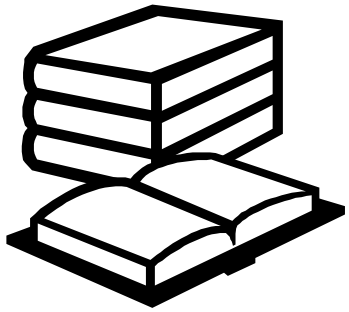
Five new documents

- Contain both old and new cover technology
- Focus on military needs in
  - Planning
  - Negotiations with regulators
  - Design and construction
  - Long-term maintenance operations
  - Interaction with contractors
  - Land reuse



New AFCEE Resource Titles

- **Landfill Covers for Use at Air Force Installations**
- **Survey of Air Force Landfills, their Characteristics, and Remediation Strategies (includes a database)**
- **Decision Tool for Landfill Remediation**
- **Landfill Remediation Project Manager's Handbook**
- **Golf Courses on Air Force Landfills**



Available from the Air Force Center for Environmental Excellence
http://www.afcee.brooks.af.mil/er/ert/erthome.htm

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Conclusions

- Conventional barrier covers are available for use
- Alternative covers have potential for
  - Improved protection of human health and the environment
  - Large cost savings
- ET cover technology is available
- Military manager has new and better resources available from AFCEE